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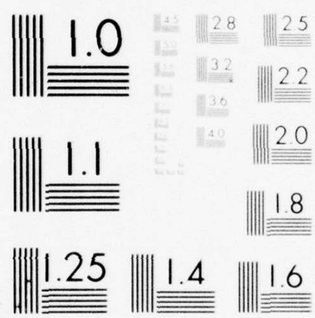

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

PROGRAM MANAGEMENT COURSE INDIVIDUAL STUDY PROGRAM

CYBERNETICS
An Overview

STUDY PROJECT REPORT
PMC 76-2

Guy G. Zimmerman
Major US Army

FORT BELVOIR, VIRGINIA 22060

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE: CYBERNETICS: An Overview

STUDY PROJECT GOALS:

To provide an overview of cybernetics, identify selected topics for future study and compile a basic list of sources.

STUDY REPORT ABSTRACT:

A systematic review of the literature was conducted through the facilities of the DSMC library to find literature dealing with the subject. Cybernetics is defined and the development of the subject from conception to fledging science is advanced. The higher system to which it belongs is proposed along with several methods for studying those systems. The language of cybernetics is discussed and selected terms are defined. A simple working model is presented. Various partitions of the pure and applied cybernetics are shown. Finally, three topics for future study are proposed because of the apparent value cybernetics has in studying the relationships between systems.

SUBJECT DESCRIPTORS: Cybernetics
Control

NAME, RANK, SERVICE	CLASS	DATE
Guy G. Zimmerman, Major, Army	PMC 76-2	October 1976

CYBERNETICS

An Overview

Study Project Report

Individual Study Program

Defense Systems Management College

Program Management Course

Class 76-2

by

Guy G. Zimmerman
Major US Army

November 1976

Study Project Advisor

Mr. Ed Speca

EXECUTIVE SUMMARY

Cybernetics is the science of communications and control or the study of the interrelationships between systems without regard to structure. The word cybernetics is from the Greek word for steersman. Although it dates back to Plato, it was used by Norbert Wiener, a mathematician, and his collegues who were neurosurgeons, in 1948 to define the new relationships they had discovered between differing sciences.

Cybernetics deals with systems. Systems are defined to be anything that consists of parts connected together. The movement toward a systems approach in modern society has three main sources: 1) Bertalanffy's "General Systems Theory", 2) Norbert Wiener's "Cybernetics", 3) the demands of engineering. Boulding noted two ways to study systems and in his second method classified systems into nine levels from simple framework to transcendental systems. Beer advanced a third method of classifying systems by the parameter--control.

Just as with other disciplines, cybernetics has a language of its own. Most of these terms, however, are familiar to other sciences because of the interdisciplinary nature of cybernetics. Information, feedback, variety and the

black box all have definitions which are scientifically and mathematically precise but mean relatively the same as in normal usage. Others which are more difficult are homeostatis, entropy and ultrastability.

Cybernetics has been difficult to partition into areas of study because of its wholistic approach. Generally, it can be separated into pure cybernetics and applied cybernetics. Each of these can then be broken down into subcategories.

The final section describes three topics for future study by students of cybernetics. The first topic of study is to model the systems acquisition process. The second suggestion is to compare an analytic and cybernetic paradigm as it relates to weapons systems acquisition. Finally, various applied cybernetic concepts can be studied to better control the project management office.

Cybernetics as the science of communications and control or the study of the interrelationships between systems without regard to structure offers a new and promising area for investigation within the systems acquisition process.

ACKNOWLEDGEMENTS

I wish to acknowledge the faithful help of Ms Blanche Shiflett, librarian at DSMC who managed to acquire the needed books on the subject of Cybernetics. Thanks must also be given to Mr. Ed Speca for his pioneering spirit in allowing me to present new material to the DSMC. Finally, thanks to my wife who literally flew to my side to type the final report.

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I. INTRODUCTION

> I think that cybernetics is the biggest bite out of the fruit of the Tree of Knowledge that mankind has taken in the last 2,000 years. But most of such bites out of the apple have proved to be rather indigestible--usually for cybernetic reasons (2:34).*

If this is in fact true then we should be busy getting down to the business of making it digestible. Cybernetics is the science of communications and control or the study of the interrelationships between systems without regard to structure. Management or more specifically the program manager is the steersman or governor that controls the movement of the log downstream. But that is the Greek derivative of the word cybernetics, ie. steersman or governor. Thus the two are alike, inseparable, and dedicated to the same end.

While the original purpose of this paper was to give me an insight into cybernetics, I had no idea that I would become such an avowed proponent of introducing and using cybernetics in the systems acquisition management field. Throughout the DSMC lectures, study guides and readings in the field of acquisition; there has been a plea for additional

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*This notation will be used throughout the report for sources of quotations and major references. The first number is the source listed in the bibliography. The second number is the page in the reference.

feedback, control and real time reporting. This too is the essence of cybernetics. The program manager is one of the most dedicated cyberneticians throughout the whole government and yet very little is said about it.

The purposes of this paper are to: 1) fulfill the requirements for an individual study project within the DSMC, 2) gain for myself an understanding of cybernetics, 3) provide an overview for others who may desire to use this paper as a stepping stone for more detailed research into cybernetics, 4) compile a small basic introductory bibliography. Others must be the judge of items 1, 3, and 4 but the fulfillment of the second purpose has been a two edged sword; for while I have gained an understanding of cybernetics, I have also gained a desire to know more about it and to use it in the solution of systems acquisition management problems.

Understandably the scope of the paper was limited by the available time one could devote to it in the school. Yet as an overview the scope was originally not intended to exclude nor to delve too deeply into any one area but rather to provide a broad brush as a first cut for students. Unfortunately, as the research grew those parts of cybernetics which are filled with numbers and logical symbols have been excluded.

For reasons stated above the organization of the paper flows not necessarily from an analytical methodology

nor from a cybernetic methodology but rather from the viewpoint of a novice looking in and trying to determine in advance what it must contain and how it would look.

In Part II, Development, the beginnings of cybernetics are explored. In addition to discussing the who, when, and where of its development, I try to show three ways of looking at the larger systems to which cybernetics belongs according to noted authorities. The intention here is to place the subject into perspective.

In Part III, various terms unique to cybernetics are defined. For reasons pointed out, one may have heard these same terms used in a different way in other disciplines. A simple example of cybernetics is described as well as a common generalized model. Finally, for analytic minds who feel they must partition all knowledge into categories in order to better organize and deal with it, I have presented several ways of partitioning cybernetics.

In the final part I have presented three selected topics for future study. Methods to approach these topics are suggested and the most obvious disadvantages or advantages inferred. It is hoped that I have also teased the reader with just enough of the ideas involved to cause him to delve further into the study.

II. THE DEVELOPMENT OF CYBERNETICS

Cybernetics is one of the youngest of the "sciences." It can scarcely be termed much more than twenty-five years old by formal accounts of the literature. There are those, however, who have traced the word back to Ampere (1775-1836) (28:15) and Parsegian begins his first chapter with a quote from Plato's Clitophon.

> "The cybernetics of men, as you, Socrates, often call politics . . ."
>
> Plato (428-348 B. C.) (27:1)

This is no wonder for the word cybernetics coined by Norbert Wiener and his associates was from the Greek word for steersman. They noted that the earliest writings done on feedback were by Clerk Maxwell in 1868 who wrote about governors and that the Greek terms for governor and steersman were very close. For our purposes, as well as the popular and common conception, cybernetics was originated by Norbert Wiener in 1948 (40:11).

The Beginning

In 1948 when Wiener published his book *Cybernetics*, there was a great stir among the scientists and mathematicians around the world. As men took time to assimilate the concepts, there were those who began to discover the word "cybernetics"

or various Greek derivatives such as kybernetike in other writings. Particularly concerned were the French who found the word in earlier writings by Littre and Larousse. The use of the word spread rapidly and soon the news media began to use it. Guilbaud notes that, "the word cybernetics now finds itself associated with robots, with electronics and so on. Indeed, as a adjective, 'cybernetic' threatens to go the way of 'atomic' and 'electronic' in becoming just another label for the spectacular . . . in view of the growing number of abuses of the term certain scientific circles now hesitate to use it and consider dropping it altogether." (22:3). This problem, well stated, came to pass in America where a literary search for material relating to the subject of cybernetics is made even more difficult by the aversion of American scientists to use the word. There are few listings in libraries under the word cybernetics. Classifications of the word under the Library of Congress system finds books with listings in the social sciences area of statistics, economics, psychology, mathematics, and biology. While it is true that cybernetics deals with all of these areas, this points up the fact that there are not many books in this area. This problem is said not to exist to as great a degree in the European countries and in Russia the term is said to be common and well used (12:18). The problem can only be resolved by referring to definitions. Guilbaud notes, however, that ". . . cybernetics

does seem to fill a gap in our vocabulary, and it would be difficult to think of a substitute." (22:3).

The word aside, the idea for cybernetics was an evolutionary process. From the writings by Maxwell to the book by Wiener was no easy step. Wiener and some of his college friends at Harvard during the 1930's began to see some similarities between the sciences. Then during World War II, Wiener, Rosenblueth, and Bigelow published a paper that was to some degree a forerunner of the idea. Rosenblueth was a neurophysician while Wiener was a mathematician but it appears that their ideas and problems were similar. Quoting Wiener:

> Thus, as far back as four years ago, 1943, the group of scientists about Dr. Rosenblueth and myself had already become aware of the essential unity of the set of problems centering about communication, control, and statistical mechanics, whether in the machine or in living tissue. On the other hand, we were seriously hampered by the lack of unity of the literature concerning these problems, and by the absence of any common terminology, or even of a single name for the field. After much consideration, we have come to the conclusion that all the existing terminology has too heavy a bias to one side or another to serve the future development of the field as well as it should, and as happens so often to scientists, we have been forced to coin at least one artificial neo-Greek expression to fill the gap (40:11).

Notice that Wiener and his associates were aware of two areas: 1) living, 2) machine. And, they were also aware of problems in these two areas that had a center in one of three disciplines: A) communications, B) control,

C) statistical mechanics. Corresponding to this is the fact that they could not communicate across the areas or disciplines concerning these problems because of a language problem. Thus cybernetics was born.

What Is It?

Because cybernetic systems are probabilistic, complex, generally large, purposive, self-regulating, and exist regardless of structure it is difficult to get a handle on exactly "what" cybernetics is.

The Encyclopaedia of Cybernetics points out that authors do not agree on whether it is a Science (description of the environment), a technique (influencing the environment) or both (19:39). Wiener himself felt that it was the science of communications and control and so named his book that way. Subsequently, it appears to have taken on an even broader scope than he originally envisioned. It has nothing to do with machines although machines may be cybernetic. Parsegian makes the best case by stating that it is the study or "search for the general relationships among phenomena (27:vii)." He continues by stating that the most prevalent reason that things get into difficulty is because the relationships are not understood. Cybernetics aids in understanding these relationships. True it is not a panacea for all problems and has rarely given concrete and complete solutions in the past, yet it almost always results in improving the understanding

of the problem at hand (27:3). When pursuing the cybernetic approach to systems, cybernetics as such, "treats ways of behaving". It is not as concerned with "what is this thing" as "what does it do?" (1:1).

If perhaps, there is still doubt as to what cybernetics is a look at the larger system to which cybernetics belongs should be discussed.

The Higher System

The whole idea of cybernetics revolves around the idea of system. While it is tacitly agreed that most everyone has his own definition of a system, one's definition does in fact determine to some degree the manner to which he understands and works with cybernetics. Beer defines a system by saying that, "Anything that consists of parts connected together will be called a system." (3:9). It is this latter one to which we shall refer.

General Systems Theory

Increasingly in our modern society, there has been a movement or trend to what has been referred to as the "systems approach", "systems theory", "systems analysis", or "project analysis", theory of management. These may all be lumped into a larger named grouping known as General Systems. Ludwig Von Bertalanffy refers to the roots of general systems theory as coming from three main sources: 1) Bertalanffy's "General

Systems Theory" 2) the expression of cybernetics as presented by Norbert Wiener, 3) the demands of engineering in the modern industrial world so aptly used beginning with World War II (37:61).

Three Classifications of Systems

The noted economist Kenneth Boulding has suggested two ways of approaching theoretical systems. Using his first method we could build a model of systems by using the "phenomena approach." In this technique one would look at various phenomena that are connected across all boundaries and seek to build models of these phenomena. Two such examples are: 1) the interaction of an 'individual' of some kind with its environment, 2) growth of something such as an individual, corporation, institution or system (9:197). It should be readily apparent and agreed that cybernetics contains and is contained in these universal phenomena. Bouldings' second method of classifying systems is to build a theoretical model of hierarchies. He lists nine levels as seen in Figure A. Note that cybernetics fills the third level of this model. If one believes in General Systems Theory, cybernetics fits readily into this overall concept.

A third method of classifying systems for theoretical model building was advanced by Beer as shown in Figure B. This method is by the parameter--control. The cross hatched areas are those most beneficially studied by cybernetics.

Two of these, The Economy and The Company, are fertile areas for study by systems acquisition management. More will be said about this under the section on topics for future study, but first we need to take a look at the language of cybernetics, some of the concepts involved and attempt to partition it so that we may grasp a better understanding of its possibilites.

Figure A

LEVEL	TYPIFICATION
Transcendental systems	Ultimate and unknown
Social organizations	Business and government
Human level	Symbol interpretation
Animal level	Specialized information
Genetic-societal	Plants
Self-maintaining structure	Cells
CYBERNETICS	Thermostat
Simple dynamic system	Clockwork
Static structure	Framework

Kenneth E. Boulding, "General Systems Theory: The Skeleton of Science," Management Science, April, 1956, p. 197.

Figure B

Systems	Simple	Complex	Exceedingly Complex
Deterministic	Window catch	Electronic digital computers	Empty
	Billiards	Planetary system	
	Machine-shop lay-out	Automation	
Probabilistic	Penny tossing	Stockholding	The Economy
	Jellyfish movements	Conditioned reflexes	The Brain
	Statistical quality control	Industrial profitability	The Company

Stafford Beer, Cybernetics and Management, Science Editions (New York: John Wiley & Sons, Inc., 1959), p. 18.

III. CYBERNETIC CONCEPTS

The Language

Inherent to any theory, science, or discipline one finds some sort of language. It may be the language of the oil well driller, physicist, or program manager. Cybernetics is no different and like other disciplines, it has borrowed words from many diverse areas. The fact that cybernetics is interdisciplinary is all the more reason that it has borrowed from other fields. Two common examples that are frequently cited are homeostasis and entropy--the former from biology and the latter from thermodynamics. Johnson, et al., have noted the need for an interdisciplinary language but recognized that "the 'new' cross-disciplines often create a jargon or 'in' language that compounds the communication problem further" (23:7). It is helpful for one to know some of the concepts and terms of cybernetics in order to better understand it.

With reference to the wholistic systems concept, let us restate our definition of a system as an array of components. In discussing the language and concepts of cybernetics, it will also be helpful to think of cybernetic systems as having three general characteristics: 1) they are extremely complex, 2) they are probablistic in nature,

3) they have the feature of self-regulation (33:277). The first two of these were noted earlier in general systems theoretical model building (Figure B). Self-regulation will be better understood after noting some other terms.

<u>Control</u>.-- can be thought of as the connectiveness of a system. It is the stickiness that makes the array of components continue to be an array rather than many isolated components. Thus in any cybernetic system we must maintain control or the system will fly apart. Control is maintained by feedback.

<u>Feedback</u>.-- is one of the more important concepts of cybernetics. Beer noted that feedback was a desired output attained by self-regulation and the input was adjusted by the output itself (3:29). Ashby agrees in principle and deals with feedback using his transformational notation (1:81). Feedback is that information which comes full circle from an output back to an input and provides knowledge to the system to control the next discrete bit of output.

<u>Homeostat</u>.-- is a particular control device that supplies the feedback necessary to maintain the system. It actually does two things according to Beer. First, it must hold the critical variable of the system between some specified limits (limits which are set by the internal system and not by the outside as such). Second, the homeostat assumes (tends toward) a special kind of equilibrium known as ultrastability (5:153).

Ultrastability.-- is the ability to restore the equilibrium of the system regardless of the kind of disturbance that affects it. That is to say, the system will return to equilibrium even if disturbed by a cause that was unknown to the designer. This too is like everything else in that it is obviously not absolute. The system cannot work if completely destroyed by an outside force. The system achieves "ultrastability within physiological limits for a range of behavior within environmental limits . . ." (5:153).

Complexity.-- can be thought of as the size of the system or the number of elements becoming interconnected and elaborately designed. If it tends to indescribability then it is referred to as exceedingly complex. In order to work with complex systems, it is necessary to reduce the variety. This is done not to make it more simple by having fewer components but to make it more predictable. The main way to reduce variety is by information (3:43).

Information.-- in its simplest form can be thought of as the recording of a choice between two events or alternatives. An example of such an event would be the dichotomy of choosing between heads and tails on the toss of a coin (a decision). The alternatives must be equally likely (probabilistic). More generally it can be defined as the degree or amount of organization in a system (3:43).

Entropy.-- has been defined to be the negative of information and as such measures the amount of disorganization in a system. Another way of stating this is by saying that entropy is the quantity of variety in a system. One particular bit of variety that can in no way be distinguished from any other variety is called "noise". If noise is introduced into the system then the variety has been increased and therefore the uncertainty (1:174).

The Black Box.-- is one approach to solving some of the problems of the complex and exceedingly complex system. This is a case of being concerned with the inputs and the outputs without knowing what goes on inside the black box. That is, it is behavioristic. This is what Ashby means when he says that cybernetics is concerned not with "What is it?" but "What does it do?" (1:110). Thus the theory of the black box is studying the relationships of information flow between the experimentor and his environment.

Self-regulation.-- requires the feedback or control loop discussed above. Dechert notes also that it requires "a functional distinction between perception, decision-making and action." This can be achieved by structurally distinguishing between perceptor, control, and effector elements (12:15).

Receptor Elements (sensors).-- are located on the peripheral of the system near the boundary and detect the changes in the environment. The information detected is transmitted by the system to a control element.

Control Elements.-- are the decision-making elements or the logical elements in the system. It is a comparator that matches information from the receptor element and the objective. This element transmits orders to the effector element in terms of the difference between the objective and sensed value.

Effector Elements.-- are on the system boundary. Their function is to manipulate the environment in a way described by the information sent from the control element in order to achieve the objective (12:15).

A Simple Model

One of the more common concepts or ideas found in cybernetics revolves around the use of information flow, feedback and output. An everyday example of the cybernetic process could be shown by describing a man reaching for a pencil on a desk. The complex interaction of input from the eye to the brain, the communication from the brain to the muscles and the contraction of the muscles to move the arm is a cybernetic process. With each nearly infinitesimal but discrete cycle of information the hand draws nearer until

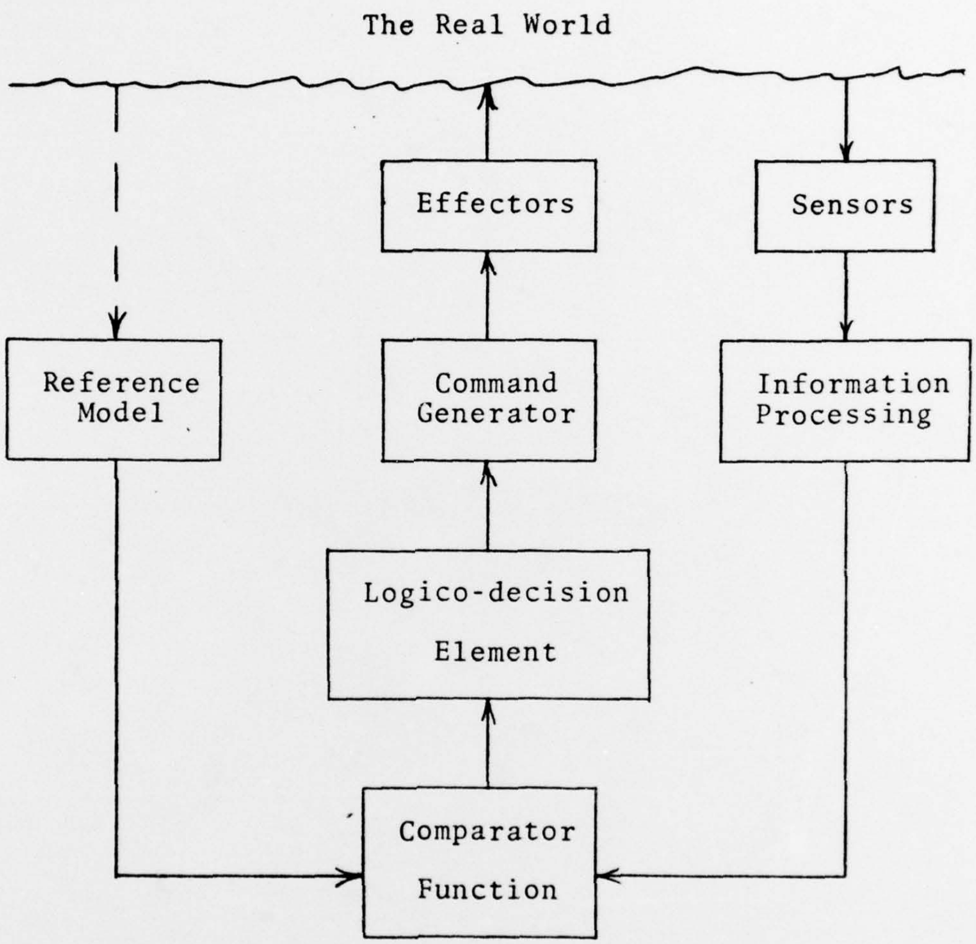
both the eye and the touch tell the brain that the pencil has been reached. No part of the man nor his brain actually computes all of the complex mathematical equations necessary to guide the hand to its destination but rather an iterative process at high speed has compared the actual with desired to produce the result. If the brain, hand, muscles and eye did measure the distances and calculate mathematically the equations necessary to place the hand on the pencil then we could be sure that the process was causal and the model of classical analytical logic. But we know that it does not. It is not possible nor needed. We merely compare desired with achieved and iterate at high speed to achieve the result. Of course in an adult this is smooth and well done because of practiced burn-in but the first time a child tries it, it is jerky at best. Thus we have the cybernetic paradigm. A more generalized model of a similar process is shown in Figure C.

Partitions

Because of the generally wholistic approach cybernetics uses to analyze and synthesize relationships between phenomena and because of the absence of a need for structure, it has been difficult to partition cybernetics into neat little areas that allow for study. Nevertheless, as the science has evolved various areas have emerged. It may be broken into pure cybernetics (that is, a formal, general

Figure C

Simplified Block Diagram of a Cybernetic System



John J. Ford, "Soviet Cybernetics and International Development," in The Social Impact of Cybernetics, ed. by Charles R. Dechert (Notre Dame: University of Notre Dame Press, 1966), p. 177.

abstract study) and into applied cybernetics (that is, regional or concrete). Formal cybernetics makes mathematical, statistical and logical inquiries into relationships. Applied cybernetics deals with the study of relationships between plants, animals and machines. ". . . applied [cybernetics] is relevant to everything human beings do, especially how they learn, how they make decisions, how they plan and how they solve problems." (18:2). A more rigorous partitioning is shown in Figure D.

Dechert noted that cybernetics helps control man, his institutions or groups and machines. As such he has broken it into three areas: 1) The theoretical division using mathematics and logic. 2) The control and controlling functions of machines and information. 3) The entire scope of applications of methods and means in life (12:19).

Figure D

TABLE ON PARTITIONS

<table>
<tr><td rowspan="8">Pure Cybernetics

(General and abstract)</td><td colspan="3">Applied Cybernetics</td></tr>
<tr><td>Engineering</td><td>Bio-cybernetic</td><td>Informational</td></tr>
<tr><td>(Physical)</td><td>(Physiological)</td><td>(Psychological)</td></tr>
<tr><td rowspan="3">Theory of information processing</td><td>Neurocybernetic</td><td>Communications</td></tr>
<tr><td>Physiocybernetic</td><td rowspan="2">Anthropo-cybernetic</td></tr>
<tr><td>Cybernetic Control</td></tr>
<tr><td colspan="3">Technical Cybernetics</td></tr>
<tr><td>Machine</td><td>Biological</td><td>Sociological</td></tr>
</table>

Encyclopaedia of Cybernetics, Translated from the German Lexikon der Kybernetik by G. Gilbertson, Manchester University Press, ed., Frau A. Muller (New York: Barnes and Noble Inc., 1968) p. 39.

IV. SELECTED TOPICS FOR FUTURE STUDY

As was mentioned in the introduction, the imagination and creativity of the college must come to bear on new ways to manage. The following three study topics are suggested as embryo projects for investigation and study in furthering a cybernetic approach to systems acquisition managment. Each is broadly stated to allow for freedom and creativity. Selection of any topic in its entirety would probably result in a project too large for an individual student and therefore may be appropriate only to a study team.

A Cybernetic Model of the Systems Acquisition Process

This study would entail a comparison and modeling of the five phases of the acquisition process with the cybernetic model presented by Beer. Simply stated he seeks ". . . to promote the study of management at an elevated level, where we should be more concerned with the nature of things and their structural relationships than with operational matters which are strictly consequential. The higher management is about a policy calculus." (6:33).

Essentially Beer postulates five management systems by comparing and contrasting with those of the human body. The first three are vital systems for autonomous control

(nervous system). The fourth is the big switch or linking mechanism (synapse) and the fifth is the thinking chamber or volitional system (brain).

There are three ways this could be studied. The first would be by laying out the systems acquisition process block by block and system by system and comparing it sequentially with the various systems proposed by Beer. The second method would be to block out the model of the systems acquisition process and attempt a one-for-one overlaying with the systems model proposed by Beer. (He uses plenty of diagrams.) The last method would be to begin with the cybernetic system proposed and try to fit the systems acquisition process to it.

In addition to the prospect that we may find a whole new approach to the systems acquisition process, the value to be gained by the first two approaches is that by studying the interrelationships we may better know and utilize the present systems. However, the third approach appears to have the greater promise of producing new ideas, concepts or methods of operation useful to management of systems. This is because as Beer states:

> . . . people look in the wrong place for the threads which unite organizational theory. The major thread unravelled by management cybernetics is the thread of variety--its generation and proliferation, its reduction and amplification, its filtering and control. For variety is the very stuff and substance of modern management in a newly complicated milieu, just as physical matter was the stuff and substance with which our fore fathers had to wrestle. (6:290).

A Comparison Between the Analytic Paradigm and the Cybernetic Paradigm as it Relates to the Weapons System Acquisition Process

Consider the case of the project manager who has three alternatives A, B, and C. If we allow him complete discretion in ordering his values he may like A better than B and B better than C. Therefore, one may say that he likes A better than C. But real life shows this to be not necessarily true. A childrens game that illustrates this is the paper covers stone, stone breaks scissors, scissors cover paper. This is the simplest transitive relationship. Lacking an objective method of establishing value the analytic paradigm allows the decision maker this freedom which he in fact cannot make. The cybernetic paradigm on the other hand makes no value judgement and in fact is not concerned with the final results in determining these values but rather monitors selected inputs to which it is sensitive and continues to feedback until it has reached a satisfactory equilibrium. This is more analogous to the DSARC and congressional budgetary process where we are continually monitoring the sensitive variable of cost, performance and schedule in order to react to the environment.

There are three ways in which the student could attack this study topic. The first is in a manner similar to John Steinbruner, from whose book this section is taken (36). He first explains the analytic paradigm, then the cybernetic

paradigm and finally discusses the politics of nuclear war in a cybernetic context. A similar technique limited to systems acquisition could be undertaken. The major disadvantage would be the size of the project and the difficulty in writing clearly the complex concepts. A second method of attacking the problem would be to ignore the exposition of the analytic paradigm, assume that readers know how the system works, and then develop a cybernetic paradigm of the systems acquisition process with all of its attendant theories and models (30)*. A final suggested method would be to model the cybernetic paradigm to a case study, perhaps even a text book example which has a given solution (31:20). This would allow reducing the size and scope of the project. While this would be the hardest and require the greatest thought it has perhaps the greatest promise of reward in that it hasn't been done. Additionally, it steps out on a completely new foot without being encumbered by the old ways.

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*See the chapter by J.O. Wisdom, "The Hypothesis of Cybernetics."

An Application of Selected Cybernetic Concepts to Acquire Better Control Within the Project Management Office

This particular study topic envisions raking through the literature on cybernetics and developing selected concepts, ideas, and methods of handling complex variables and applying them to the program office. No particular effort would be made to convert to a general theory of cybernetics but rather the bits and pieces would be applied in the current context of the analytic model we now use. Of particular value may be the application of feedback. Another might be the reduction of variety. All of Beer's books have sections on both of these topics. Additionally, the irrationality of rational man may prove a fruitful concept to be applied in the program office especially around DSARC time (13).

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